

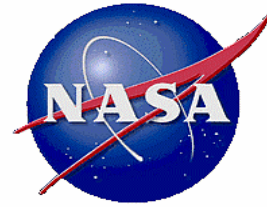
NASA's New Risk Management Paradigm

**Presented at the NASA Project Management
Challenge 2009 Conference**

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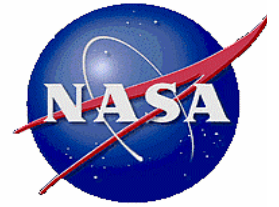
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**Homayoon Dezfuli, Ph.D.
Office of Safety and Mission Assurance
NASA Headquarters**



Background

- NASA's Risk management (RM) approach is governed by NASA Procedural Requirement (NPR) 8000.4
- The latest version of the directive (NPR 8000.4A) was issued on December 16, 2008
 - Accessible from NASA Online Directives System (NODIS) Library
 - <http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=8000&s=4A>
- The latest RM directive introduces major changes to the Agency's RM approach



Historical Perspective on NASA Risk Management

- RM has always been a key component of NASA program/project management process
- No “formal,” systematic RM process in NASA until mid-’90s
- Then came “Continuous Risk Management” or “CRM” process:

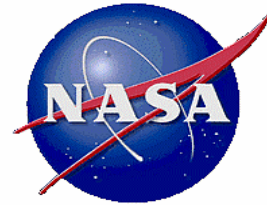
Strengths

- + Was a well-established, mature paradigm originally developed for DoD
- + Was accompanied by a fully developed, off-the-shelf training program
- + Helped focus the agency’s managers on the need to consider risk in program management
- + Was formalized in NPR 8000.4 effective April 25, 2002
- + Trained a large number of NASA personnel in the fundamentals of CRM

Weaknesses

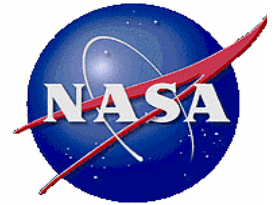
- Applied mainly to programs/projects
- Placed emphasis on “management” of individual risks (given a decision already made somewhere else), but not on influencing key and direction-setting decisions
- Was mostly a localized process
- Lacked rigor in risk identification, analysis, and treatment of uncertainties
- Gave little attention to cross-cutting risks

- We took the next step in the evolution of RM
 - Issued NPR 8000.4A



New Revision of NASA NPR 8000.4A

- **Other motivating factors:**
 - Expiration of NPR 8000.4, April 25, 2008
 - Publication of new NPDs, NPRs, and handbooks; e.g., NPD 1000.0, Governance and Strategic Management Handbook; NPD 1200.1D, Internal Control and Accountability; NPR 7120.5(7 & 8), Program and Project Management Requirements; NPR 7123.1, Systems Engineering Processes and Requirements
 - Past mishaps, failures, and study group recommendations
- **Attributes of This Version:**
 - *Systems* approach to risk management
 - Proactive risk management: better inform decision making through better use of risk information, and more effectively manage implementation risks
 - Close alignment of risk management process with decision-making process
 - Allowance for graded approach (rigor of the process and level of resources are adjusted to the needs of the organizational unit)
 - Consideration of aggregate risk (where feasible) to support risk tradeoff studies
 - More emphasis on treatment of uncertainty
 - Implementation of risk management in the context of complex institutional relationships (programs, projects, Centers, contractors, ...)



Intersection of Product-oriented and Discipline-oriented NPRs

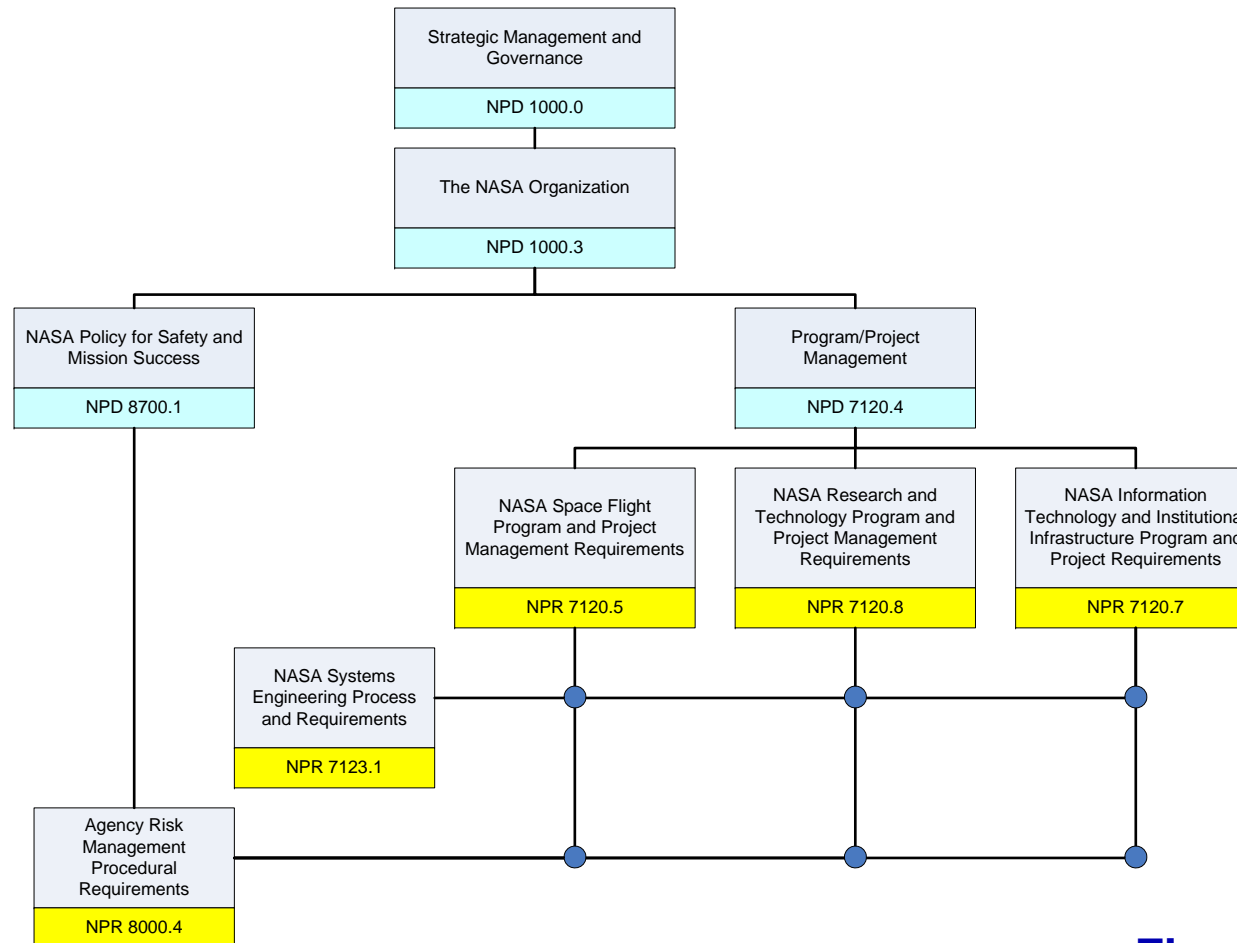
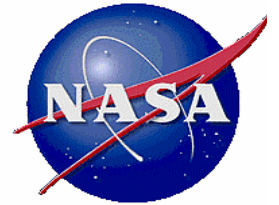
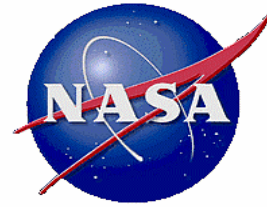


Figure 1 of the NPR



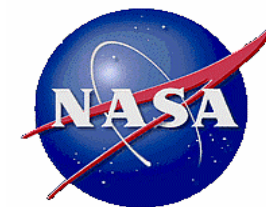
Excerpt from the Preface of the NPR 8000.4A

- **Paragraph P.1a**
 - This NASA Procedural Requirements (NPR) document provides the requirements for risk management for the **Agency, its institutions, and its programs and projects.**
 - Risk Management includes two complementary processes: **Risk-Informed Decision-Making (RIDM) and Continuous Risk Management (CRM).**
- **Paragraph P.1b**
 - This NPR also establishes the roles, responsibilities, and authority to execute the defined requirements Agency-wide. It builds on the principle that **program and project requirements should be directly coupled to Agency strategic goals, and applies this principle to risk management processes within all Agency organizations at a level of rigor that is commensurate with the stakes and complexity of the decision situation that is being addressed.**
- **Paragraph P.1c**
 - The implementation of these requirements leads to a risk management approach that is coherent across the Agency and achieves appropriate coverage of risks (including cross-cutting risks) within NASA. “Coherent” means that (a) **Agency strategic goals explicitly drive RIDM and, therefore, CRM, at all levels,** (b) **all risk types are considered collectively during decision-making,** and (c) **risk management activities are coordinated horizontally and vertically,** across and within programs, projects, and institutions.



Use of Two Complementary Processes for Risk Management

- **Risk-informed Decision Making (RIDM)**
 - To inform decision making through better use of risk information in establishing baseline performance requirements (e.g., safety, technical, cost, and schedule requirements) for program/projects and mission support organizations
- **Continuous Risk Management (CRM)**
 - To manage risk associated with the implementation of baseline performance requirement



Flowdown of Performance Requirements

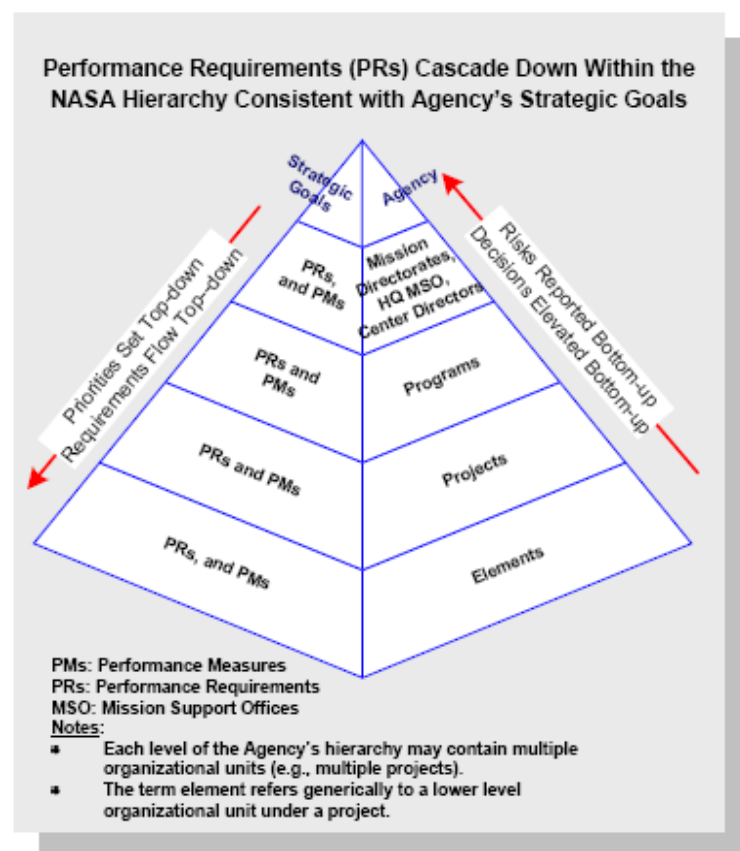
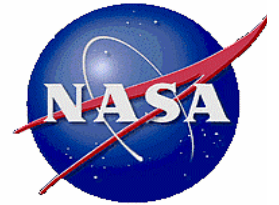


Figure 2 of the NPR



The RIDM Process

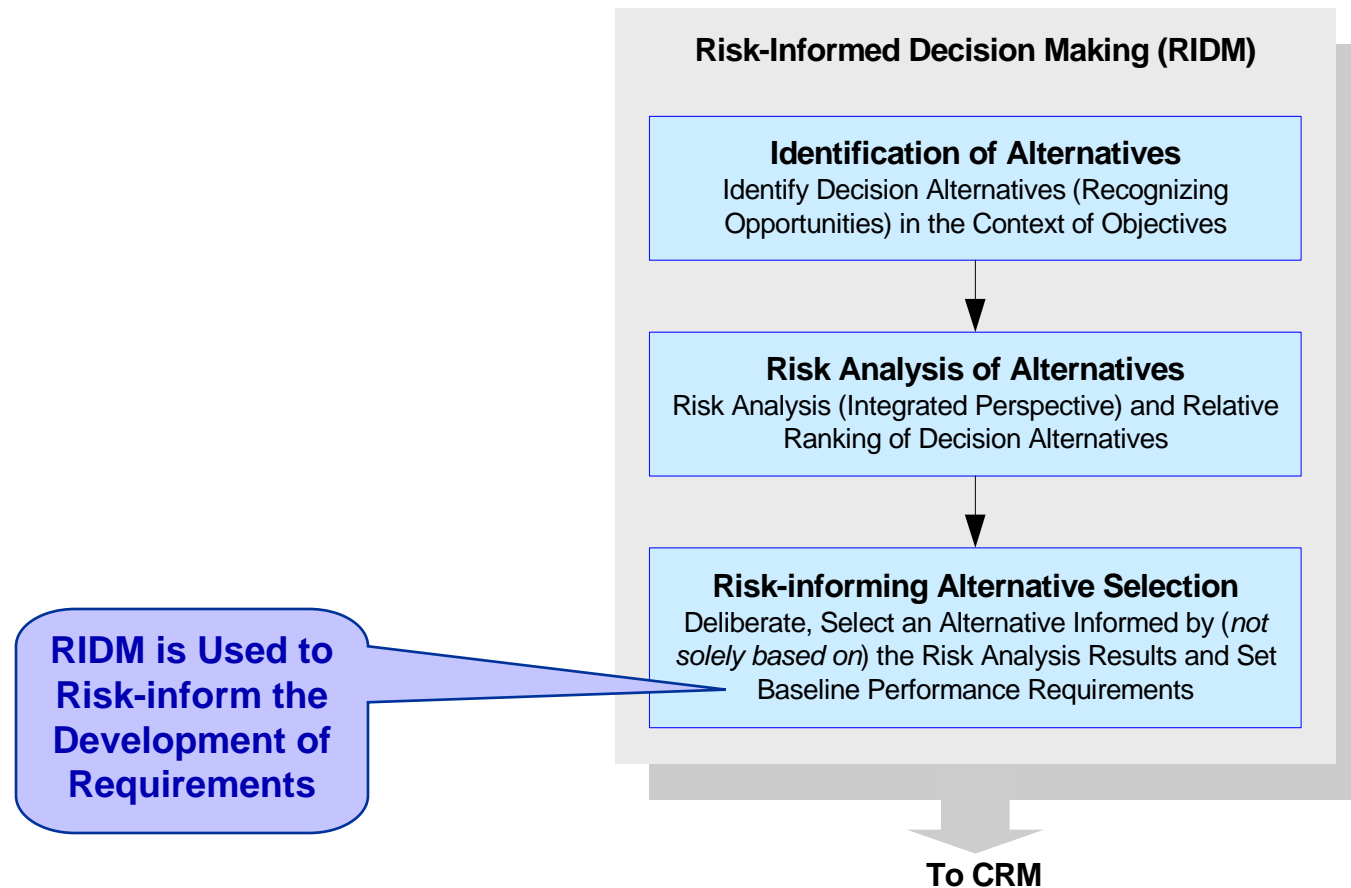
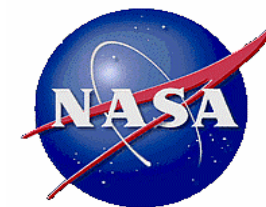
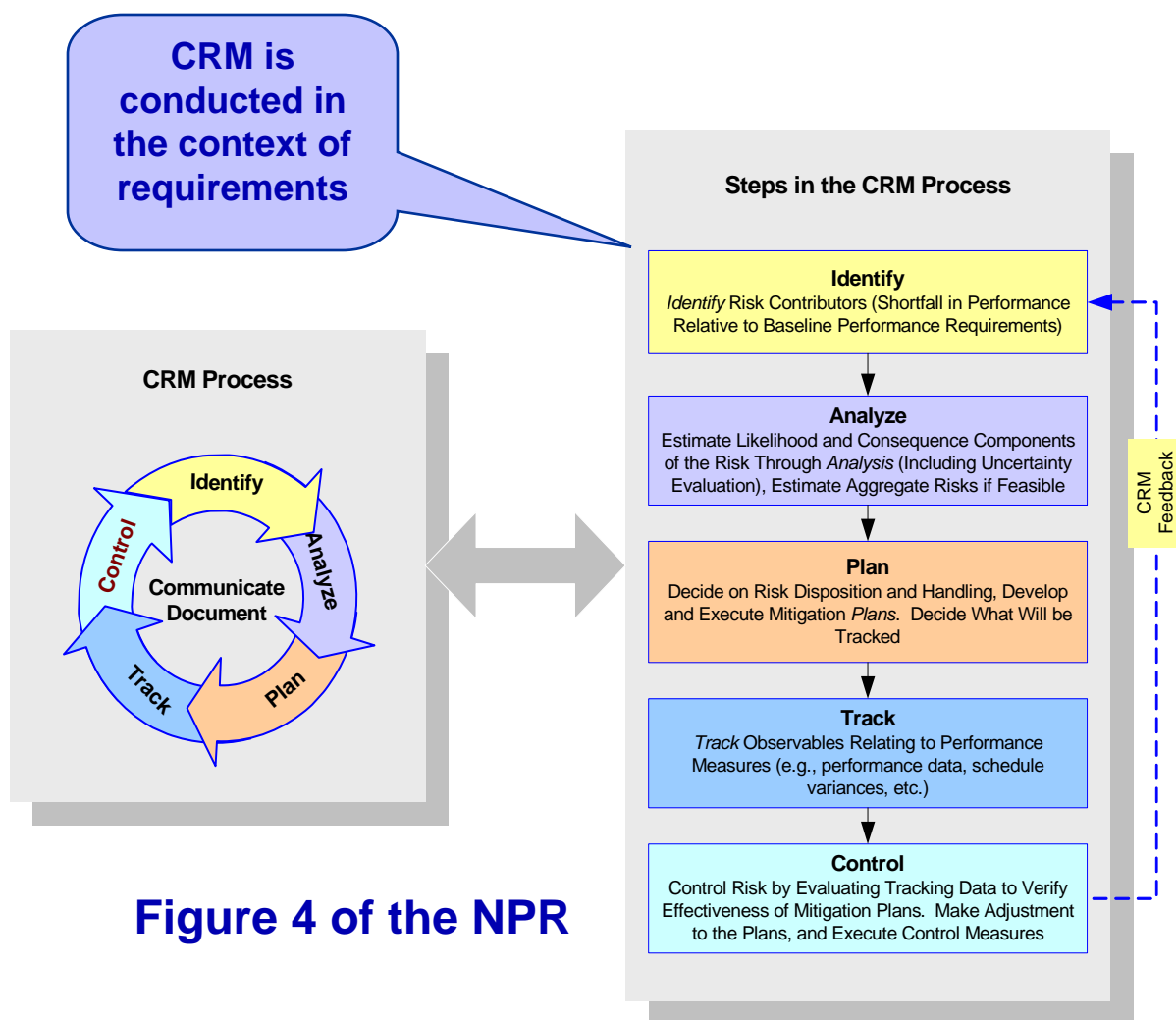
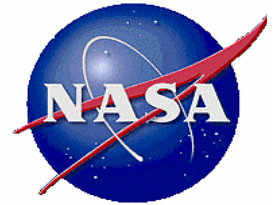


Figure 3 of the NPR



The Continuous Risk Management (CRM) Process





Coordination of RIDM and CRM Within the NASA Hierarchy

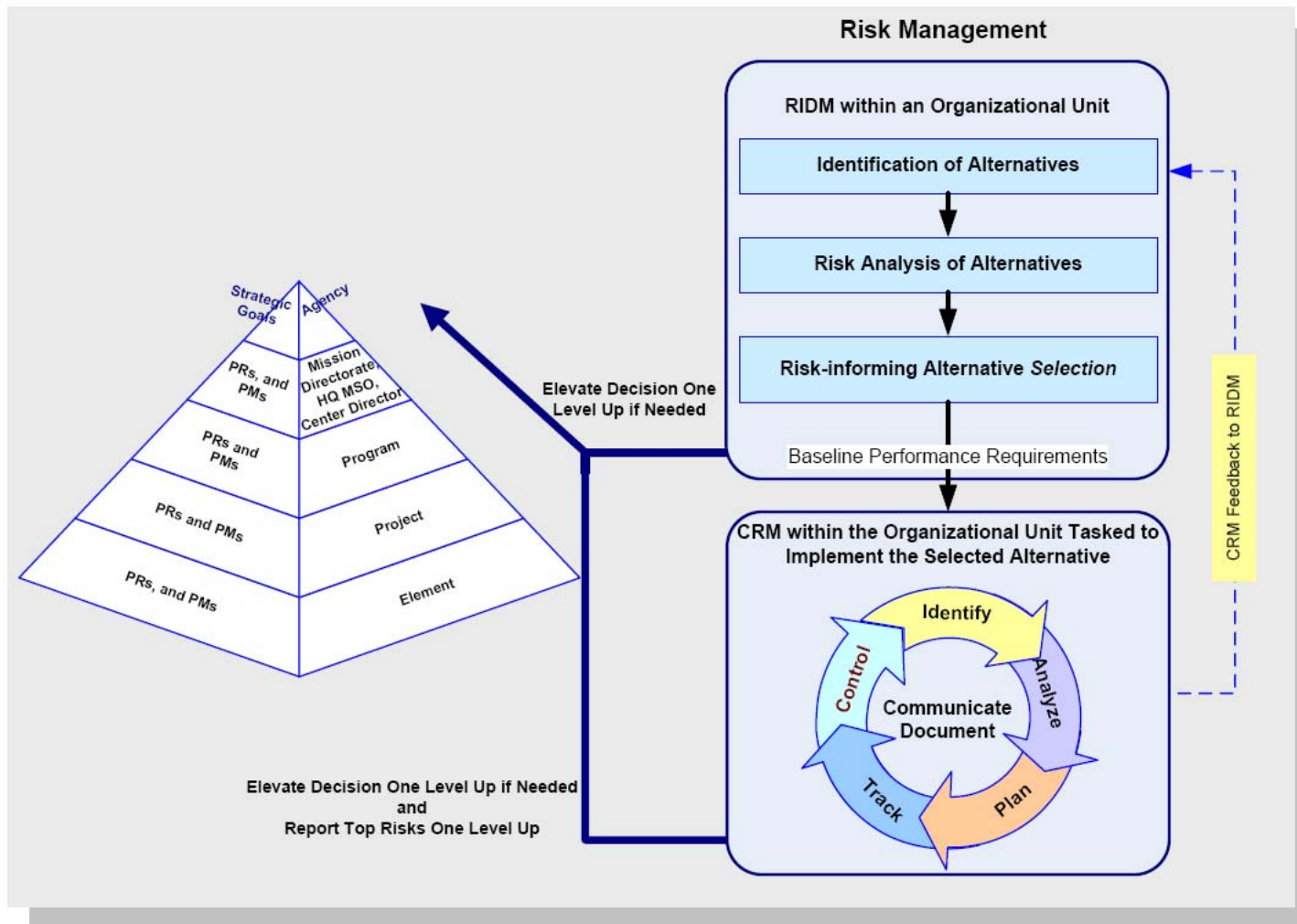
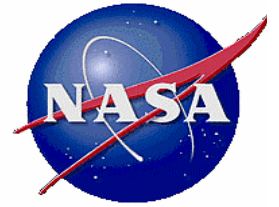


Figure 5 of the NPR



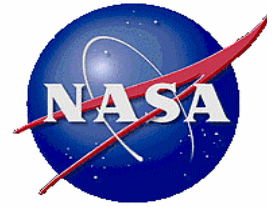
Old RM Paradigm vs. New RM Paradigm

In the old RM paradigm

$$\mathbf{RM} \equiv \mathbf{CRM}$$

In the new RM paradigm

$$\mathbf{RM} \equiv \mathbf{RIDM} + \mathbf{CRM}$$

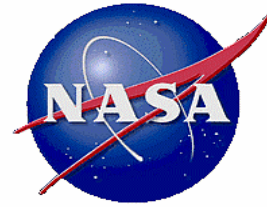


Definition of Risk

- **NPR defines risk as**

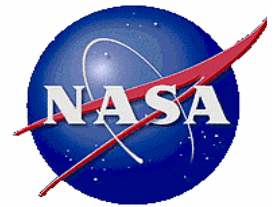
“Potential for performance shortfalls, which may be realized in the future, with respect to achieving explicitly established and stated Performance Requirements”

- **The performance shortfalls may be related to**
 - **any one or more of the following mission execution domains**
 - **Safety**
 - **Technical**
 - **Cost**
 - **Schedule**
 - **institutional support for mission execution**

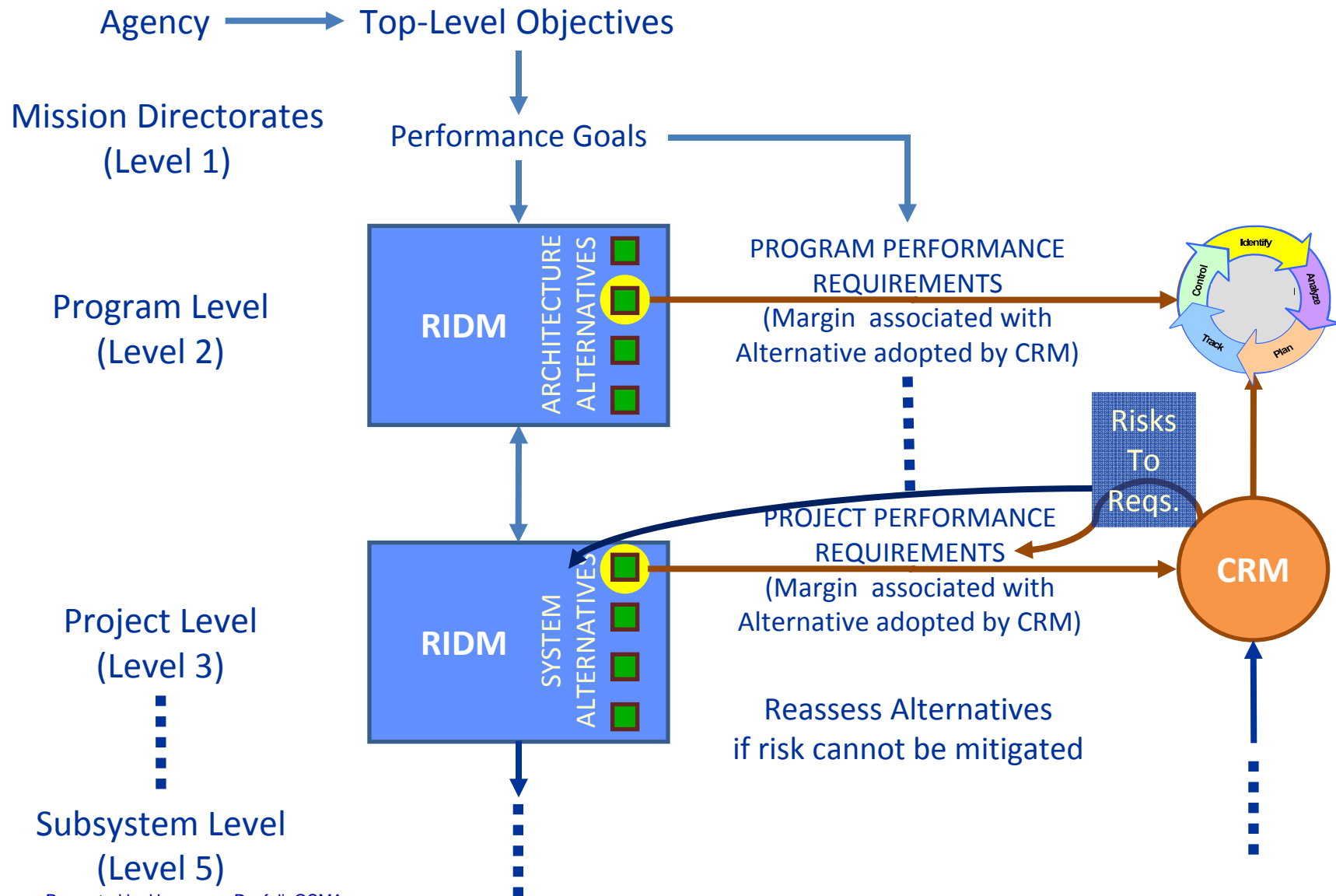


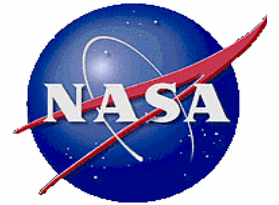
Operational Definition for Risk per Paragraph 1.2.1c

- **NASA's decisions for managing risk involve characterization of the three basic components of risk:**
 - (1) The *scenario(s)* leading to degraded performance with respect to one or more performance measures (e.g., scenarios leading to injury, fatality, destruction of key assets; scenarios leading to exceedance of mass limits; scenarios leading to cost overruns; scenarios leading to schedule slippage);
 - (2) The *likelihood(s)* (qualitative or quantitative) of those scenario(s); and
 - (3) The *consequence(s)* (qualitative or quantitative severity of the performance degradation) that would result if the scenario(s) was (were) to occur.



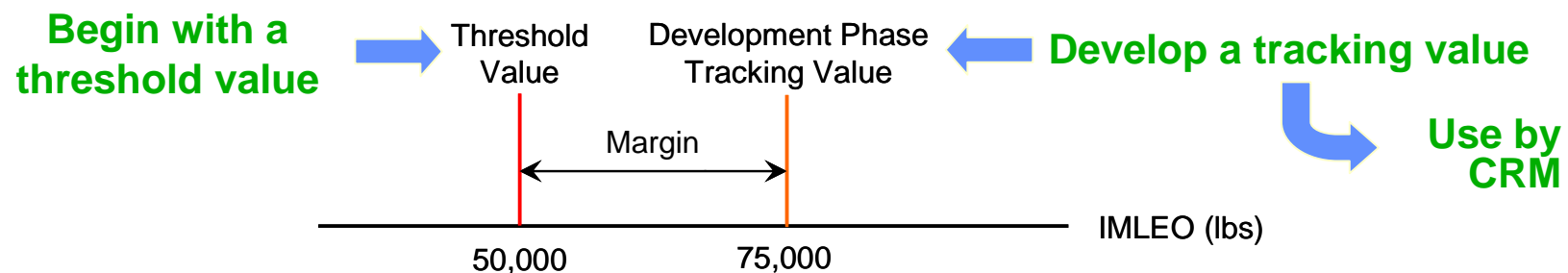
Conducting RIDM and CRM in the Context of Performance Requirements

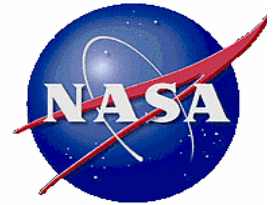




Performance Requirements and Margins

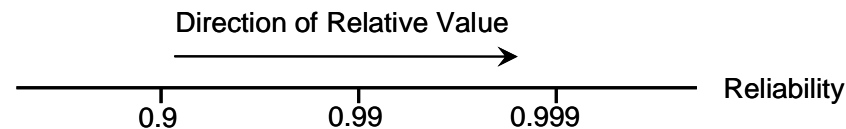
- A *performance requirement* consists of:
 - A performance measure (PM), i.e. the attribute to be measured
 - A threshold value, i.e. the value of the PM that must be met in the final product, and
 - A development phase tracking value, representing a design-to value that is appropriate for a particular program/project life-cycle phase
- Performance requirement development starts with a PM and threshold value, e.g. *carry a 50,000 lb payload to LEO*
- PM analysis must include development margin to account for the inherent optimism of early PM assessment
 - This produces the *development phase tracking value*, which is the value that is used by the CRM process to assess/track compliance during development





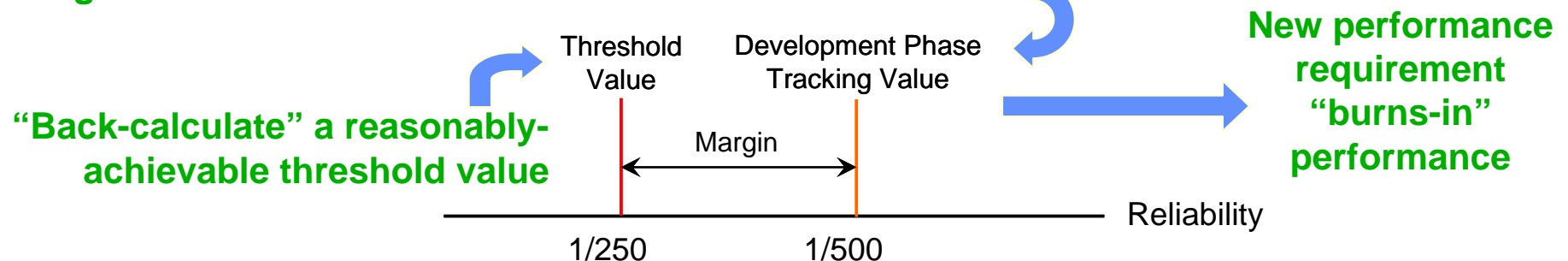
Performance Requirements and Margins (cont.)

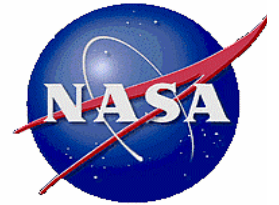
- A performance goal consists of:
 - A performance measure (PM), i.e. the attribute to be measured
 - A direction of relative value, i.e. a direction of goodness



- Decision alternatives are informed by the extent to which each option maximizes the performance goals
 - E.g. the performance goal, *maximize reliability*, might produce a (mean value) PM estimate of 1/500 for a particular alternative
- The inherent optimism of the assessed PM value is recognized; therefore a development margin is applied to essentially *back-calculate* a reasonable PM value to achieve in the final product
- For the selected alternative, a new performance requirement is derived from the performance goal and “burns in” the performance that motivated the selection

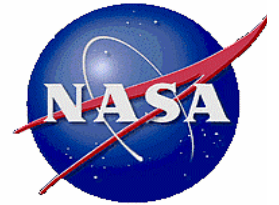
Begin with the assessed value of the selected alternative





Challenges and Needs

- **CRM**
 - Introducing more formalism and technical rigor into the CRM process
 - Risk identification and analysis and communication
 - Willingness to accept and learn advanced and new tools and techniques
 - Subscribing to an integrated approach to risk management (synergistic management of risks)
 - Conducting the CRM in the context of mission requirements
 - Need for coordination of CRM activities
- **RIDM**
 - Recognizing the proactive nature of the process (e.g., developing risk-informed requirements)
 - Need for coordination of existing systems engineering processes (decision analysis and technical risk management) and probabilistic risk assessment (PRA) activities with the RIDM process
 - Skills in analytic, integrated modeling approaches
- **Institutional risks**
 - Presently they are being managed to some extent in an ad hoc fashion
 - Need to formalize these activities
- **Benefit**
 - The collective benefit of these changes is a risk management process that supports better decisions, is globally coherent across the Agency, and manages risks (including cross-cutting risks) within the appropriate hierarchical units of NASA



In Summary

- **RM now spans the Agency, top-to-bottom and end-to-end**
- **RM is driven by Performance Requirements and Performance Measures**
 - At the highest level, performance requirements are the Agency's Strategic Goals
- **RM=CRM+RIDM**
 - Preserving the Continuous Risk Management (CRM) process
 - Adding a framework around the CRM process that establishes the infrastructure for risk-informed decision making in the NASA organizational hierarchy
 - Implementing the CRM process in the context of performance requirements emerging from the RIDM
- **“Organizational Unit Management” at all levels takes a more active role in managing risks**
- **The stature of “Risk Manager” is enhanced**
 - Risk Managers will be sought out for input to decision-making
- **There is new emphasis on:**
 - More formalism and technical rigor
 - Consideration of aggregate risk for risk tradeoff
 - “Institutional” risk management
 - Cross-cutting risks
 - Formalizing decision elevation